FippleFlute - Recorder Maintenance

Simple Tuning and Repairs

Keeping ones instruments in first class working order is always a problem, even with recorders, although the techniques are never as obvious as with, for example, changing the strings on a guitar. What follows is a gentle guide to the art of recorder maintenance for those players who like jumping off cliffs and that sort of thing. All others - please send it back to the maker!

Basic Maintenance - Outside appearance

It wasn't until I bought my first good saxophone that I realised just what an effect the purchase of a new instrument can have. Until then the recorders in my workshop had just been things I lived with every day, usually covered in a fine layer of dust until polished up for exhibition, but now I was facing this beautiful, shiny, silver, mechanical marvel and I WANTED IT!!! Could it be that my customers felt the same? Well of course they did! Beauty is, after all, only skin deep, but it does appeal!
The external finish on recorders varies widely depending on the maker/factory that they came from. Starting at the bottom, makers of plastic instruments have either said 'this is plastic –learn to love it' or 'well it may be plastic but from a distance lets try and pretend its not' and have used various wood look-alike finishes. There's not a lot you can do with it, except, like a damp muddy pooch, give it a good soak occasionally in a bucket of warm, soapy water.

I once got into a great deal of trouble by drawing attention to the deposits of food that were seriously compromising the tone of a plastic descant in a festival at which I was adjudicating. The boy's mother nearly killed me, and I was never asked back!

Cheaper wooden recorders will have some sort of spray-on varnish, which will easily become chipped and scratched. I would treat it like your car. Rub it down with fine wet and dry or steel wool, and then spray it with cellulose lacquer, either clear, or as close to the colour as you can find. Some friends of mine make a small profit by buying mass produced wooden recorders from E-bay, stripping off the varnish, delivering a few well aimed blows with a battle-axe or similar, and then selling them at a premium to medieval re-enactors who absolutely love the battle scarred finish. You can certainly do this with paint stripper and sandpaper if you like, and you may well find a very nice piece of pearwood or maple beneath, but don't take off too much thickness of the wood or you might change the tuning.

High-end recorders will have a more subtle finish involving stain, either acid or aniline, or a natural wood finish with oil or wax to resist finger dirt. At its simplest, if a recorder is black, then the wood will be either blackwood or ebony, and there will most likely be no external finish. If it's really mucky, clean it off with the finest grade of steel wool, OOOO, and then use either an oily cloth, or wax polish it.

A digression on oils. Those you will mostly come across are almond oil, linseed oil, and tung oil, the last two often with hardeners added for quick drying [eg. Liberon Finishing oil]. Almond oil does not dry, and is therefore used mostly for the bore. Drying oils should not be used in the bore as they can build up to give a nasty, crusty, patina that may get into the fingerholes, and could affect the tuning. You can use a drying oil on the outside, but be very careful not to leave an accumulation in the fingerholes. Drying oils will not 'dry' on a recorder made from oily woods such as blackwood, or one that has been impregnated with paraffin wax. They will just make a sticky mess which you will have to clean off with white spirit or similar.

Boxwood recorders come in two sorts, real boxwood [buxus sempervirens] and fake [various yellow hard woods from the tropics]. It can be difficult to tell them apart, but it is unlikely that a hand maker will use anything other than real European boxwood. Boxwood will often be stained or dyed in various shades of brown, and once again it is difficult to tell between the two. Traditional acid staining travels into the surface of the wood, and is often uneven in colour, but because this follows the grain of the wood, it is not unpleasing to look at. The recorder will probably have been soaked in linseed oil, and this will also have penetrated the wood and dried. Minor scuffs can be treated with 0000 wire wool, as removing a small part of the surface will not penetrate either the stain or the oil. The finish can be restored with an oily cloth to leave a thin coat [see note above], or wax polished. Some American hand makers use an aniline stain. This does not penetrate the wood surface, and is all too easily removed, so do not use wire wool or you will very quickly end up with a patchy yellow and brown finish. I must confess that I am not quite sure how to restore the finish here, so I tend to leave well alone. Some German high-end factory models also use a surface stain that seems to have been applied with a sponge or similar. Once again, this can be easily damaged. You can identify these stains as they are evenly distributed, and do not follow the grain of the wood.

The Bore

A healthy bore, if seen in a strong light, will be nicely polished and oiled from end to end, with no fluffy bits. As you can imagine, the vibrating air column does not like fluffy, spiky, or sharp edges, and works better without them. I once traumatised the SRP by suggesting that wire wool on the end of an electric drill could be used to polish bores. I still stand by that opinion, but it should be done carefully.

The places where you are most likely to encounter sharp, fluffy or spiky bits are in the fingerholes, so have a good look down them in a strong light. A fingerhole has two edges, inside and out, and between is a surface of wood that can collect oil, sweat, fluff and general grime. Go to a home brewing shop and buy a very thin nylon bottle brush, the sort that is used for cleaning out plastic tubing. Cut it down to 5 cm or so and use it to clean out the fingerholes.

Afterwards use cotton buds with alcohol to really clean the sides. If you are feeling braver, polish the hole with some 400 grit paper wound round a drill bit small enough to go in the hole and dunked in some almond oil, but be very careful not to enlarge it. An improvement to the tone can often be made by smoothing off the sharp corner of the hole as it meets the outside of the recorder.

Inside the bore, the best cleaning method is with a bottlebrush, and these can be purchased at specialist recorder shops, or just from your local kitchen supplies.
The notorious Cranmore 'wire wool on the end of an electric drill' can be used if the surface of the bore is very rough, but not to excess or this will change the bore characteristics and the tuning. Get a bicycle spoke, or similar length of fairly rigid wire, either bend a loop into the end or cut a slot with a fine hacksaw, and thread a hank of medium grade steel wool into it.

Always insert this into the bore before switching on the drill, or it will thrash wildly out of control, and switch off before taking it out for the same reason. When you have smoothed the bore to your satisfaction use some recorder oil on a bottlebrush, or if the wood seems very dry, immerse the centre joint and foot joint for a day in an oil bath if you have enough. The head joint can be immersed, but all traces of oil must be removed from the block socket before it is replaced. Oily blocks can be cleaned with acetone or some other oil solvent. Soak the block for a day, and all that unwanted oil will be washed out into solution.

The Voicing

I have been voicing recorders for 30 years and I still don't really understand it. All I do know is that the sound that comes out of your tube of air is a truly international one. All parts of the tube contribute, and all of them have to be considered. A mistake that I often made, as presumably did everyone else, is to look for a magic bullet that will conquer all the faults in one fell swoop. [what is a fell swoop? – sounds a bit like bog snorkelling]. The fact is that, in constructing a voicing, you are balancing surfaces, angles, directions, air flows, air pressures, any one of which could profoundly disturb the sound if you get it wrong, and in my case nearly all by hand and eye, not in a computer controlled Autocad system. For example, at the windway exit there are many angles, surfaces and dimensions , all of which have to match, be symmetrical, and correctly guide the airflow.
It is in this situation that we come up against the engineering problem, no, not one that you solve with a lump hammer, but a problem with engineers, who profoundly believe that if you have the right information and sufficiently accurate machines, then any product can be turned out in any numbers with the same reproducibility as a Rolls Royce crankshaft.
I have seen an engineer spend an inordinate length of time setting up a massive computer controlled milling machine to make a cut that I do in 10 seconds with a hand operated scalpel, and the machine still got it wrong. A recorder looks to an engineer like an 'engineered' product, and in fact 90% of it can be treated as such, but the last 10% needs skill, experience, and, dare I say it, creativity to make it all come together.

The voicing of a wooden recorder can, and will, go horribly wrong. It is, after all, designed within a rectangular tube of two different woods, with different grain structures and absorbencies, which are then subjected to a continuous rain of body fluid.

As nature abhors a vacuum, the ecosystem, which is subsequently created, will soon be colonised by all manner of flora, and occasionally fauna, and the wooden container will twist and turn and rise and fall with the seasons. Factory produced recorders whose costing does not include a lengthy blowing-in session, attempt to forestall this by waterproofing the wood with paraffin wax, and by starting with a windway that is beyond the optimum specification for its function, thereby giving the floor and ceiling leeway to move.
Hand makers will always blow the recorder in for some time before letting it out of the workshop, and will re-voice several times during the process. If the voicing has gone off, it will most likely result in tightening of the sound with some edginess and extraneous noises, and this is nearly always caused by the block surface rising as it absorbs water, or a build up of deposits.

The idea of having a cedar block is that it can absorb a certain amount without expanding and either disrupting the voicing or splitting the head joint, but this is not infallible. Various solutions have been used, and these have included chemical stabilisers, and the notorious ceramic block from a well-known German manufacturer, which occasionally disintegrate after some years of use.

If you are going to work on the block of a wooden recorder, it helps to be able to get it in and out, and this can be scary. Look down the windway into a strong light. Can you see the labium? Is the windway nice and symmetrical or do the corners seem rounded off? Are there little black things growing from the top of the block? Is anything walking around or waving its legs at you? I still remember the noise made by an earwig as it hit the wall after a friend had sucked it out of a windway. If the answer to any of these is yes then the block might bear removal. If you have a friendly recorder maker round the corner then refer to him, but as these tend to be rarer than polar bears at the equator, why not have a go.
Planning is everything. Find or turn a dowel with a diameter slightly smaller than the head joint bore and with a smooth end, and a hammer! Take the head joint in one hand, insert the dowel, and point the beak at your lap, and hit the exposed end of the dowel. One of three things will happen; The block will come out –well done! – the block will come halfway out - hit it again – or the block will not shift. In the last case try hitting the dowel harder, but if there is absolutely no movement it is best to leave the recorder for a week to dry out thoroughly and try again. If you still have no success refer to your local recorder maker.

Blocks you might find

Tapered block – fits into a tapered socket in the head joint – easy to remove and replace but not too easy to adjust backwards and forwards

Straight block – fits into a parallel socket in the head joint. Not easy to remove or replace, but can be easily adjusted backwards and forwards

Socketted block – fits into a section of the bore that is larger than the sounding bore, but fits against a shoulder in the bore and cannot be moved beyond that.

Two part block (comes in three versions)

1. A cedar block with the centre removed and replaced with another cylinder of cedar with flexible cement between the two. Designed to prevent expansion of the block
2. A cedar block in two parts with a square section glued into a groove, which has been machined into the top surface of the block and forms the upstand. A means to speed up and simplify block production
3. A cedar block with a ceramic insert as the windway floor intended to absorb excess moisture. These are no longer used as they have tended to disintegrate, and the whole block usually needs replacing

Windway blockages you might find

1. Food, spit, lipstick, fag smoke, need I go on? – recorder makers occasionally need a strong stomach.
2. Fungus, usually seen as a series of pinhead size lumps which you can feel with a fingertip inserted into the bore.
3. Paraffin wax – usually seen in mass produced recorders that have been left in the sun.
4. Fluff from those abominable fluffy cleaning sticks that used to be standard equipment with every new recorder.

All these will be on both the windway and the block, but can be cleaned off with care, using mechanical or solvent means.

Block cleaning

Food etc deposits really need scraping off, and as they will be mostly at the blowing end, there is less possibility of making unwanted changes to the voicing. Try one of those plastic pan scourers under a stream of warm water, or if baked hard, use fine steel wool or a scalpel blade on the dry block. The pinhead fungus will be distributed all along the windway, and once again, the best means of removal is with gentle scraping with a scalpel blade.

Always scrape away from the windway exit so as to not touch the end chamfer. Some people will say that a certain amount of slime on the block surface helps spit to slip through easily and avoids blocking, but if the windway size has been reduced than it needs to go.

Windway cleaning

Not so easy! Have a look at the wind channel with a strong light, and once everything has been cleaned off you can become familiar with the shape that both the block and the windway should be. In a decent instrument, both windway roof and the block surface will have been made with a slight concavity. The chamber created between the two accelerates the airflow so that is it at its fastest when it exits from the windway. You can see it by carefully laying a straight edge such as a 6" steel rule along the surface. The rule should only touch either the block or the windway roof at the very ends. If there is a bit of a 'hill' in the middle of either, then the wood may have moved, and you may feel like adjusting it yourself if you are feeling particularly brave. However, just restoring the windway to its default manufactured state must be done very carefully, as you don't want to remove any of the original wood unless you are entering the uncharted waters of DIY voicing.
Hard blockages will probably be either food or paraffin wax. Wax can be very difficult to remove as is does not dissolve in any solvent generally available at the hardware shop, so it is better scraped. For both food and wax you can use a small file with the end ground down to a square edge and the file serrations smoothed off. This will certainly be necessary to get into the corners of the windway. For the centre a small bit of steel wool on a finger tip will do the job. For softer deposits or fluff use a cotton bud with alcohol.
While you are in cleaning mode have a look at the window. You will often find that the corners of the window exhibit the same gunge as the windway, and they can be scraped away with a scalpel. If a fluffy cleaner has been used there will also be bits of fluff embedded everywhere. [ps. If you have one of these, it is best burnt immediately so that it can never be used again!]. These will interfere with the airstream by vibrating in it, and you can spend a lot of time individually removing them!

Block replacement

What comes out must go in? – not necessarily, especially if the block has come from a parallel socket, when you may well find that the end of the block appears not to fit the hole it came out of. When re-fitting a block it is best if you have a sliding fit, so that force need not be used. A tight block can be reduced in size either with abrasive paper or with a scraper. If it goes in part of the way then sticks, you should be able to see the sticking points as polished areas on the round section of the block. These can be selectively rubbed or scraped down and the block tried several times, hopefully going in further each time. I prefer a sliding fit with a good shove from the thumb, with maybe a tap from a block hammer for the last 0,5mm or so. Rubbing a wax candle along the rounded section to make insertion easier can lubricate the block.

Recorder maintenance (Advanced)

If you have read the preceding chapter carefully, you will see that, rather like looking for fleas in a shaggy coat, I am encouraging you to look closely at your instrument – probably more closely than you have ever looked at it before. Now that you have had a really good look, we can have a go at some serious obedience training!

Recorders are made from wood – wood comes from trees – it is a dead but extremely complex skeleton of cellulose, lignin, spaces, tubes and fibres, and it cannot be guaranteed to be stable. Besides, as you grow as an owner, the recorder might no longer suit your technique, or you may begin to discover irritating behavioural traits that you didn't at first notice.

I have always tried to encourage players to buy from a maker that is local to them, not just for my sake, but also for the ease of just popping up the road for adjustments and for developing a personal relationship with him/her.
Really successful makers not only have good craftsmanship but also excellent personal skills [not to mention salesmanship, financial acuity and entrepreneurial talent].

Recorder voicing

Recorder voicing is sometimes referred to as a 'dark art'. Fred Morgan was often reckoned to be the only living maker who really understood the subject, but I think we are catching up. One thing to remember is that to ascribe all the properties of a recorder to the voicing alone is to lose oneself down a blind alley. Whether a recorder 'works' or not is the combined result of the voicing, the tuning, the bore, the wood, the 'blowing in' process etc. I have always described the construction of a recorder as a cyclical process. One aspect cannot be finished in isolation. All must be addressed in turn until the final product emerges, and even this cannot be thought of as 'final' until the instrument has been used for some time. Thus, the recorder must be voiced, tuned, cleaned, blown, voiced, tuned, cleaned, blown, voiced, tuned, cleaned, blown etc etc until finished to the maker's satisfaction.

This is not intended to be a course in recorder voicing, but I will be giving away some secrets and short cuts that may be helpful to anyone who wants to have a go.
A successful recorder voicing is all about symmetry, linearity, and balance. Once again I am encouraging you to take a very hard look at your recorder. If you are short sighted take your glasses off [I remember the very first moment I did that just because my ears hurt – it was a revelation], or use a magnifying glass.

On a high-end recorder you will see that the windway is curved laterally, but with a flatter curve than the bore itself. An Irish 6 hole whistle nearly always has a curve that matches the bore and seems to introduce the instability that those instruments need to break easily into higher harmonics. A whistle made with a recorder style voicing really doesn't work. I know because I've tried.

The windway is also slightly concave along its length, and the lateral curve is maintained until the windway exit.

The windway entrance controls the volume of air entering, and also the pressure. The pressure and speed of the air needed to operate the voicing at its optimum needs to be just so, and on a high end recorder an increase in pressure at the windway entrance will raise the volume of the recorder as the whistle mechanism is made to work harder, but will not appreciably raise the pitch.

The adjustable parameters at the windway entrance are the height after manufacture, and the height, width, and curve during manufacture. The reasons for a curved windway are often argued about, and I'm not sure that the advantages are immediately obvious, but baroque originals had them so we tend to expect it in our more expensive toys.
The windway exit is altogether a more complex arrangement. It is essential that the air exits in as symmetrical a way as possible so that it crosses the window in a cohesive and well-directioned flow at the right speed and pressure for the voicing to operate effectively.

'*Sounds difficult?.. Believe me it is!*'

Like you are doing now, I once had a good look at the window of a recorder and realised that there are at least 10 surfaces, 12 dimensions, 9 lines and 7 angles that have to be orientated with each other.

The surfaces are;
· The north side of the window perpendicular to the windway
· The south end of the block
· The underlabium which joins the labium to the bore
· The ramp which joins the labium to the external turning · The two sides of the window which confine the sides of the airstream
· The top surface of the windway
· The top surface of the block
· The top windway chamfer
· The bottom windway chamfer .

The dimensions are;
· The height of the windway entrance.
· The width of the windway entrance..
· The height of the windway exit.
· The width of the windway exit. · The depth of the window.
· The size of the two chamfers.
· The thickness of the labium.
· The height of the windway roof above the labium.
· The height of the labium above the block surface.
· The length of the underlabium.
· The length of the labium

· The longitudinal position of the block within the bore

The lines are;
· The labium itself, with which all the other lines are orientated. · The four lines which comprise the edges of he top and bottom chamfers .
· The two top corners of the windway.
· The two bottom corners of the windway where block meets the bore

The angles are;
· The angle of approach of the windway.
· The angle of both chamfers.
· The angle of approach of both the labium and the underlabium
· The angles made by the sides of the window as they come to the surface.
· The angle made as the labium flares out to the surface.Not to mention the fact that many of these are curved,and that the curves have to match!

I should point out that I hardly ever measure anything in the voicing. I just look at it. The eye is a marvellous comparator, and after many years I can judge dimensions much better that any measuring instrument that I could possibly afford.

You can see that the possible permutations of these lines and surfaces are overwhelming, but there are two things to remember. There is no such thing as a correct set-up, just one that works for you and the instrument, and that the greater the symmetry, the better the result. For example, the chamfers must be parallel to one another and to the block and windway. If they are not, the air stream will not exit correctly and will cross the window in a disturbed fashion.

To begin with I am only going to suggest that you try adjusting two of these, namely, the position of the block within the windway, and the relationship of the block surface to the labium. Later, we will move to processes that actually involve cutting into the main body of the recorder, but as these are by their very nature irreversible, I might ask you to sign a disclaimer first!

Looking and seeing

I sometimes suspect that we see what we want to see. Have you ever looked for a skylark that is singing merrily above [yes, we still have them in the Malvern Hills], and totally failed to spot it, then suddenly, when it is in view, you can’t miss it. When I have asked players to look down a windway and describe what they see, they often seem to see nothing at all, or at least not what I am talking about.

Take your block out, and identify the north and south ends of it. Look down the empty headjoint and identify the windway and the labium. Now replace the block and see how they relate.

You should be able to see the space between the labium and the windway roof, the labium itself, and the gap beneath the labium as seen along the top surface of the block. [It is often said that the sign of a quality recorder is that the gap visible below the labium should not have any visible light, and this is often taken to mean that the block is sufficiently high that no direct light can be seen.

However, if you think about it, you might not be able to see light if the windway slopes upwards [re-entrant], or if the centre of the underlabium is not coincident with the bore, but actually joins the bore some distance behind the labium itself.

A common problem with recorders after some use is that the block rises so that there is no direct sign of the labium, or it can only just be seen above the block surface. The symptoms are a scratchy tone, especially on the high notes, and a tendency to blockage with spit. The cure is often to lower the block surface so that the labium is visible once more.

There are two ways to do this. The least invasive is to persuade the whole block to move down without touching the top surface. Remove the block and take two strips of adhesive tape in the positions shown, either side of the upstand. Try to re-insert the block. If this is successful you may well find that the south end of the block has been forced downwards. If the block will not go in because the addition of the tape makes it too tight, scrape or sand away the curved side of the block opposite from the windway and try again. Eventually you should find that the block will enter at a slightly different angle and the edge will be visible. To adjust the block by sanding down the top surface requires that you have a very good idea of how that surface is to start with, so take a good look.

I want you to notice especially the chamfer at the south end, its size, and the angle it makes with the block surface. You will need to reproduce that when you have re-finished the surface as some or all of it will be removed. Make a drawing or take a photograph. Next, lay a straight edge along the block and notice any concavity. If there is none, then you might think about introducing one. I am only talking about a fraction of a millimetre in the centre, so that you can see light under the rule in the middle but so that it touches at both ends.

Find a small square block of wood and wrap some abrasive paper [150 grade] round it. Lay the sanding block along the recorder block lengthways, and abrade the cedar lengthways, rocking it slightly from side to side to allow for the curve of the windway. Use the existing chamfer as a guide, noting that it should reduce in size equally if you are abrading the surface symmetrically. Check for concavity, and if it is not there, use the sanding block across the block , and with your thumb at the south end of the block to prevent the abrasive from quite reaching the end, abrade the wood lengthways again. Now using the block at an angle replace the chamfer exactly as it was with fine abrasive [400 or similar].

Replace the block in the headjoint and look for the labium. Blow the recorder and see if it has made a difference. Repeat the process if you feel it is necessary. If you want to raise the block again, use some adhesive tape on the curved lower side of the block opposite to the windway to force it upwards, scraping down the shoulders either side of the upstand if necessary.

The contemporary recorder developed by Martin Helder made all this unnecessary. The height of the block was adjustable using a screw thread mechanism so that the tone of the recorder could be changed from edgy to round as needed.

To investigate the effect of the block positioning, try leaving the block sticking out of the mouthpiece by a millimetre or so, or try and push it in further. See what effect this has on the tone. Sometimes you might like to change this position to suit the particular music being played at the time. Leaving the block standing out of the windway can give a breathy but fuller sound, whereas pushing it further in will give a tighter, brighter sound.

Really Major Surgery

If by now you have the bug for DIY recorder adjustment, I am going to give an overview of all parts of adjustments that can be made to the voicing and bore of a baroque recorder, and what might happen if you make them. There are no guarantees of success, and my first recommendation would be to invest in some tired out wooden instruments to practice on – EBay is a good source.

I have acquired a varied collection off EBay. Judging by the photo and the price [ie. low] alone I now have what I call my chest of recorder horrors, all of which were foisted on the public during the last 50 years or more as ‘musical instruments’ by various mass production facilities. They vary from early Bakelite jobs to American marching band plastic things that look like something from Whoville! I occasionally pass them out to a room full of teachers and challenge them to play a B in tune with each other.

It saddens me to think that these things were regularly passed out to primary school classes with the promise that they could be used to make music.

Having said that, I must admit that the plastic school recorder has vastly improved in recent years, but I still suspect [based on my own experience as a school recorder teacher] that the recorder is used as a filter mechanism. A box of assorted recorders is passed out to the class, and after a few weeks it is obvious where the more talented musicians are. It is at this point that the clarinet and flute teachers come nosing about asking if anyone is any good, and before you know it your best pupils are swanning along the corridors with a gleaming, key-festooned orchestral instrument and seem to mysteriously ‘quit’ your class!

The windway of a recorder is essentially a channel milled into the roof of the headjoint beak. It can point down into the bore and extend beyond the window as the underlabium on the same axis *[best for mass production]*, or it can be parallel to the bore and change direction for the underlabium, more often seen nowadays in mass produced instruments, or it can slope slightly upwards, and be created entirely independently from the underlabium, which is milled separately or cut with an angled knife *[the method probably used in baroque originals]*.

The height of the windway varies considerably, but the basic rule is that the bigger the windway the more air you need to put down it to make it work, and the louder the recorder could be if the rest of the voicing is properly set up.

The advantage of a large windway is the range of manipulation of the sound available to the player, but disadvantages will include coarseness of tone, too much pitch variation with blowing, and a tendency for the player to pass out! A small windway, with good focus, will give a much more precise sound, more pitch stability, and greater staying power per lungful, but can also be a bit of a straitjacket when it comes to expression.

If you want to open the windway of a recorder, the easy option would seem to be to just lower the block, and if it was too high in the first place this will give an improvement, but once the labium is visible any further lowering will quickly destroy the tone. You need to raise the roof at the south end. You can do this with abrasive paper on the end of a stick, but you may end up rounding off the end of the windway. Try to make a scraper. I use a small, square file, ground down to a scraping edge at the end, with a curve that is slightly rounder than the windway profile [pic] at one end, and a square cut at the other. The former can be used in the centre of the windway, and the latter to raise the corners.

This tool can also be used to introduce or adjust the concavity mentioned on p???. However, it can only be used successfully if the grain of the wood is on your side. Try a test scrape along the centre of the windway. If the tool cuts neatly you are in luck, if it judders along and leaves a torn surface then the grain is working against you and there is very little you can do about it except the abrasive on the stick method, and that is a lot less precise.

By raising the roof at the windway exit, you will also have removed part or all of the top chamfer, so you really need to have made a record of it in advance. Take an ice-lolly stick or similar and trim it so that it fits neatly into the window with the same width.

Put a blob of wax, plasticine, or some such on the end and press it into the top surface of the window. When you take it out you should have an impression of the top chamfer. Also, make a tool consisting of a small mirror on the end of a stick. By introducing this in the bore underneath the end of the windway in a strong light you should be able to see the chamfer through the window. You can also see the underlabium.

Re-cut the top chamfer using a new scalpel blade. A lot of this can only really be done through feel and experience. You can measure the chamfer as you go along by measuring the width of the shavings you are making, by looking at it in the mirror, and by taking further impressions. Bear in mind that this is an irreversible process. I have always used an angle of approx 45 degrees for the chamfer, but there is nothing to stop you from experimenting at this point.

Keep checking the tone of the recorder as you go along and see what a difference the top chamfer makes, and bear in mind that it must be balanced by the block chamfer, but they do not necessarily have to be the same size or angle, or even at the same point in the bore, just parallel to each other.

The Labium interrupts the airflow and introduces the acoustic vibration. A transverse wave is converted rather inefficiently into a longitudinal sound wave within the bore. The characteristics of the labium are its thickness, the distance between the centre of the labium and the bore, and its length both on the outside of the recorder and also inside the bore [the underlabium].

On mass produced recorders the labium will be thicker as this is easier to make without too many disasters. The underlabium will be long as this is also easy to manufacture. On baroque originals the labium is usually thin, with a short underlabium, which was probably cut with a knife through the window.

The only experiment that you can really do with the labium is to cut it back with a scalpel and re-profile it from the outside of the recorder. If the sound is rather tight then this can open it out, but fractions of a millimetre count here so be careful and be prepared to write the recorder off for the sake of curiosity.

The Bore and Fingerholes

The fipple may be the engine of the recorder, but the bore and fingerholes are the running gear and bodywork, and a well-tuned bore can turn a three-legged mutt into a race winning greyhound. It's like the difference between singing into a cathedral and singing into a sack of potatoes. A resonant space takes the sound and amplifies it nd feeds back on itself so that none of that energy is lost.

The most resonant bore is a parallel tube. Loud fundamental, few partials, strong basic tone. How the early makers came up with the idea of tapering the bore we will never know, maybe someone bored a recorder from both ends with a blunt bayonet and never quite met in the middle giving the first choked bore by serendipity.

However, once the idea of a tapered bore got around, makers started playing with the idea, and eventually came up with the baroque bore with its complex tapers that produce the characteristic rich sound and extended range of the high baroque originals.

I should also mention that the contemporary recorder has returned to the open parallel bore, with its loud lower notes, and persuaded it to work beyond the accepted baroque range using baroque fingering, but the subtlety of tone of the tapered bore remains far more suitable for the repertoire of the baroque period.

The fingerholes are spaced with two things in mind, that they should give the correct pitches, and also that theyhould be comfortable for the hands. On smaller recorders they can be spaced more with tuning in mind, but as the tube gets longer they have to be arranged in a left hand and right hand group. On the large renaissance originals these two groups are spaced apart from each other, and the tuning is controlled by the size of the fingerhole rather than the position, so you will see a large hole above a medium hole with a small hole underneath. If the hole position is too far for fingers to reach we see various combinations of keywork, and modern basses and great basses can be keyed throughout.

DIY Tuning is not as difficult as it sounds, but it must be followed in a logical and ordered manner. When I tune a recorder from scratch I follow a cyclical pattern, starting by tuning the recorder to about 20 cents below pitch, then cleaning the bore. This will give the voicing a chance to work better, and then I can tune the recorder again and clean it again.

If you take a note in isolation and bring it up to pitch before finalising the voicing, you will nevitablyfind that it is sharp when the recorder is finished and the recorder is working at full power. A further complication is that the bore also contributes to the tuning, and until the bore is right the tone will never develop fully.

Each hole will make a contribution to the pitch of several notes, with diminishing effect the further away you get from the first open hole. However, the higher harmonics are sometimes affected by unexpected holes, and not by others.

You can do some experimentation yourself. Play a particular note into a tuning meter, and then cover each open fingerhole in turn and see what effect it has on the pitch. You will probably end up with results something like these;

Finger hole terminology as applied to the following descriptions

O- Left hand thumb
1- Left hand index finger
2- Left hand middle finger
3- Left hand ring finger
4- Right hand index finger
5- Right hand middle finger
6- Right hand ring finger both holes covered
6a-Right hand ring finger one hole covered
7- Right hand little finger both holes covered
7a-Right hand little finger one hole covered 8- End of foot joint.

The bore also affects the tuning, and once again you can experiment by adding material to the bore in different laces and seeing what effect it has. A more dynamic way is to mount a piece of material, wax, plasticine or some such on a length of wire that is fixed to the bench, and then move the recorder on to it so that it travels up the bore while playing the same note into the tuning meter.

You will see the pitch rise and fall as the 'lump' passes various key points, and these will be different for each note. This means that any note can be tuned individually using the bore, but it is most often used for tuning octaves where the same fingering has to give two notes that are exactly one octave apart. In a parallel bore this happens via simple physics, but in a tapered bore you have to be more cunning. For example, the octave A on an alto is tuned by opening the bore between holes 1 and 2. As the bore is opened the lower A falls in pitch and the upper A rises until they meet. At that point the hole can be opened up and the pitch of both will rise together until it is correct.
When the bore is right, the lower A will also develop a harmonic allowing it to be blown more strongly,and the high E natural, [the harmonic twelfth of A] which is also controlled largely by the same hole 6 as the two As, will be in tune.

The effect of adding material to the bore can be The logical extension to this is that removing material from the bore will have the opposite effect. Have a play with it using paper or wax or some plastic cut from a curved bottle to add material. For removing material, why not try making a reamer.

All makers work from bore diagrams taken from original recorders. If you draw one out you will see that the taper is not straight, but has separate sections, some appear to be parallel, and some taper sharply. I soon realised that this is the effect of using several reamers to adjust the bore, and familiarity with this technique can make all the difference during the end stages of making a recorder.

A lot of hot air has been expended on the subject of reamers and bores. Basically, what works, works and whether a bore has been made to a tolerance of 1/100mm with a beautifully hardened, tempered and ground, fluted reamer or with a bit of wood fitted with a scraping blade makes no difference. I have seen a velvet lined drawer containing spotless steel reamers, and mine live in a plastic cutlery drawer in a mess of oil soaked shavings, and are largely made out of oak and bandsaw blade. They can produce a beautiful, long shaving, instead of a pile of wood dust, and can be made in minutes and easily discarded if faulty.

The final reaming of a recorder is not a question of reaching pre-determined parameters, but of listening to the instrument and knowing just which reamer of several to use to give it the final tweak. Engineers always start by producing one-piece reamers, which slavishly copy the bore of the original they are working from, and can never quite understand why they usually don't work.

Making a simple wooden reamer

Assuming you have a lathe and some skill with it, find a piece of oak or similar, that will reach to the point of the bore that you want to experiment with, plus 5cm for a handle. Take a diameter beyond the point you are interested in, and knock off a couple of millimetres, and decide what diameter you want to take the bore out to. Use these as your maximum and minimum. Turn the wood to these sizes minus 0.5mm. giving a cutting length of about 4-5cm to adjust a treble, and then back off from the maximum to make the stem, and turn a nice handle on the end. Saw along the reaming section leaving a D shaped section, and then take a section of band saw blade and drill and screw it to the section, so that it will cut when rotating clockwise. [I find that an old band saw blade that has done many thousand revolutions is sufficiently soft to be drillable, but still takes a good edge. In other words, ask your local woodworking shop for a broken one.] Grind it tangentially to the reamer surface until the maximum and minimum diameters are the ones you are after, and try it out.

Tuning, step by step

Overall, a simple rule is start from the bottom, and head for the top, but first you have to ask some questions of the recorder as a whole.

1. Is the recorder overall too flat? Rather than attempt to adjust each note, try drilling a small hole of 1mm diameter in the side of the head joint just by the window. This should raise the pitch overall. If insufficiently, drill two. You can always block them up if the room gets warmer.

2. Is the recorder too sharp? Pulling out is of course, an answer, but can give problems with the octaves as a space is formed between the head and the centre. Try building up the wall around the window with some wax or similar.

3. To use a treble recorder as an example, is the octave A too large, or have the low C or D got a strange hollow sound when pushed, with a high top octave? Or conversely, are these octaves too small with a weak low note and a flat top octave? If so then the only means of adjustment is the bore, and this should be done before any changes are made to fingerholes. These adjustments are treated in the following table.

Tuning table

Techniques referred to in this table include filling holes, opening holes and bore adjustment [method given above]. For opening holes, use a needle file, or a small, sharp blade. For closing holes, run thin superglue into the wall of the hole and let it dry, or melt beeswax into it using a hot scalpel blade or wire. For bore adjustments, material can be reamed out [irreversible!], or replaced temporarily with wax, or more permanently with epoxy resin or twopart varnish. This can be reamed to a new profile when properly set, and is hardly detectible on first sight.

All processes apply to a treble recorder in F

Low F. Largely controlled by hole 8. Insert wax etc. to flatten, ream out to sharpen, but bear in mind the effect on he highest notes.

Low F#. Controlled by hole 7a. Enlarge to sharpen, fill to flatten. Low G. Controlled by hole 7 and 7a. Enlarge to sharpen, fill to flatten.

Low A flat. Controlled by hole 6a. Enlarge to sharpen, fill to flatten.
Low A. Controlled by hole 6 and 6a. Enlarge to sharpen, fill to flatten, but bear in mind that this octave is very inflexible unless the bore is correct, and enlarging hole 6 will raise both high E and high F. Also controlled by the bore between holes 1 and 2. Open to widen the octave, close to narrow the octave.

Low B flat. Sharpen by undercutting hole 5 to the north, flatten by filling in on north side.

Low B natural. Sharpen by undercutting hole 4 to the north. This will preferentially sharpen B nat. in relation to low C, but bear in mind that a very sharp B nat. with an 'in tune' low C is difficult to correct, and an alternative fingering should be looked for. Flatten in the opposite way but with the same provisos.

Low C. Sharpen by undercutting hole 4 to the north, but bear in mind that this will preferentially sharpen low B nat., and this note may need an alternative fingering. If the low C is flat and 'boomy', try filling in the bore opposite the thumbhole.

Low C#. This is best adjusted using alternative fingerings, as changing hole 3 affects several other notes.

Low D. Sharpen by undercutting hole 3 to the north, flatten by filling. If low D is flat and has a rasping sound, try filling in the bore above the thumbhole.

Low E flat. Sharpen by enlarging hole 2 to the south. This will also raise high F, so consider alternative fingerings.

Low E. Sharpen by undercutting hole 2 to the north, and flatten by filling.

Middle F. Sharpen by undercutting hole 1 to the north, and flatten by filling, but remember that this hole also affects middle G.

Middle F#. Sharpen by undercutting thumbhole to the south, and flatten by filling.

Middle G. Sharpen by undercutting thumbhole to the north, and flatten by filling.

Middle G#. Sharpen by undercutting hole 1 to the south, and flatten by filling, but this is a difficult note to change.

WHILE ADJUSTING TUNING ALWAYS LISTEN TO OTHER NOTES THAT MIGHT BE AFFECTED BY THE AME HOLES - and don't go too far at once!

High A. Sharpen by undercutting or enlarging hole 6 to the south, but bear in mind that this octave is very inflexible unless the bore is correct, and enlarging hole 6 will raise both high E and high F. Also controlled by the bore between holes 1 and 2. Open to widen the octave, close to narrow the octave.

High B flat. Sharpen by undercutting or enlarging hole 5 to the south.

High B nat. Sharpen by undercutting hole 4 to the south. This note will be preferentially sharpened over high C. Flatten by filling

High C. Sharpen by undercutting hole 4 to the south, flatten by filling, but keep an ear on high B nat. If the octave is too wide, flatten high C by filling bore opposite thumbhole.

High C#. Sharpen by undercutting hole 3 to the south, flatten by filling, but keep an ear on high D nat.

High D. Sharpen by undercutting hole 3 to the south, flatten by filling but keep an ear on C#. This note is best adjusted in the bore. Addition of material just in the top joint will narrow the octave, and removal of material will widen it, but keep an ear on the tone, as too wide an octave will result in an unpleasant hollow tone to most of the middle range.

High E flat. This note is often so tied up with the other top range that the best way to cope with poor tuning is to find alternative fingerings by adding right hand fingers.

High E nat. This note is controlled by all the lower right hand holes including the end of the bore, but mainly hole 6, which is why it is so tied up with A. It is often too high, and you can adjust the bore by reaming around the end of the centre and top of the foot joint, or use a combination of hole 6 and 7 if you want to try filling.

As mentioned before, adjusting the bore between holes 1 and 2 can bring the A octave and high E into harmony with each other.

High F nat. This note is controlled by the holes at the end of the recorder similar to High e, but with the added advantage that hole 2 also affects the pitch. There may be some conflict with the low E flat, but making hole 2 larger to the south or filling it will either sharpen or flatten respectively.